AMERICAN NATIONAL STANDARD

for Secondary Network Transformers

Subway and Vault Types (Liquid Immersed)—Requirements

Prepared by:

Working Group .40 of the Underground Transformers and Network Protectors Subcommittee
IEEE Transformers Committee

National Electrical Manufacturers Association

Approved June 30, 2000

American National Standards Institute

American National Standard

Approval of an American National Standard requires verification by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer.

Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone, whether he has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

The American National Standards Institute does not develop standards and will in no circumstances give an interpretation of any American National Standard. Moreover, no person shall have the right or authority to issue an interpretation of an American National Standard in the name of the American National Standards Institute. Requests for interpretations should be addressed to the secretariat or sponsor whose name appears on the title page of this standard.

DISCLAIMER: The standards or guidelines presented in a NEMA Standards Publication are considered technically sound at the time they are approved for publication. They are not a substitute for a product seller's or user's own judgment with respect to the particular product referenced in the standard or guideline, and NEMA does not undertake to guaranty the performance of any individual manufacturer's products by virtue of this standard or guide. Thus, NEMA expressly disclaims any responsibility for damages arising from the use, application, or reliance by others on the information contained in these standards or guidelines.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this standard. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

Published by

National Electrical Manufacturers Association
1300 N. 17th Street, Rosslyn, Virginia 22209

Printed in the United States of America

CONTENTS

Foreword (This Foreword is not part of American National Standard C57.12.40-2000)

The Accredited Standards Committee on Transformers, Regulators, and Reactors, C57, has for a number of years been developing and correlating standards on transformers and regulators. The data used in this work has been gathered from many sources, including the standards of the Institute of Electrical and Electronics Engineers and the National Electrical Manufacturers Association, reports of committees of the Edison Electric Institute, and others.

The graphics and detailed work required to produce this standard were provided Mike Boulware of ABB Power T&D Company, Inc. of South Boston, Virginia.

Suggestions for improvement of this standard will be welcome. They should be sent to the National Electrical Manufacturers Association, 1300 N. 17th Street, Rosslyn, Virginia 22209.

This standard was processed and approved for submittal to ANSI by Accredited Standards Committee C57 on Transformers, Regulators, and Reactors. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the C57 Committee had the following members:

J. D. Borst, Chairman
J. A. Gauthier, Secretary

Organization Represented	***Name of Representative***
U.S. Dept. of Energy Western Area Power Administration	Kenneth C. Wolohon
Dept. of the Navy, Civil Engineer Corps.	Peyton E. Glenn, Jr.
Dept. of the Interior, Bureau of Reclamation	Boyd Leuenberger
Dept. of Agriculture, R.E.A.	Mehrdad Eskandary
Tennessee Valley Authority	F. Lewis
Underwriters Laboratories, Inc.	M. Shacker
Electric Light & Power Company (EL&P)	P. Orehek, Chairman Carl G. Neiman T. Diamantis K. S. Hanus Gary Miller (Alt.) Glenn Anderson J. Sullivan
Institute of Electrical and Electronics Engineers	W. B. Binder, Chairman J. D. Borst J. W. Matthews B. Patel T. Prevost H. Jin Sim (Alt.)

National Electrical Manufacturers Association	D. Rollings, Chairman G. Coulter P. J. Hopkinson R. Plaster H. Robin H. Jin Sim (Alt.)
Underwriters Laboratories, Inc.	M. Shacker

At the time that this standard was approved, the Working Group had the following membership:

R. L. Plaster, Chairperson

B. Klaponski	C. Niemann	R. Graham	T. Greely
W. McCain	P. Orehek	J. Sullivan	G. Miller
P. Risse	W. Wimmer	R. Butani	J. Moffat
A. Robinson	D. Mulkey	L. Dix	I. Hussain
J. Somma			

for Secondary Network Transformers
Subway and Vault Types (Liquid Immersed)—Requirements

1 Scope

1.1 This standard is intended for use as a basis for establishing the performance, interchangeability, and safety of the equipment covered and to assist in the proper selection of such equipment.

1.2 This standard covers certain electrical, dimensional, and mechanical characteristics and takes into consideration certain safety features of three-phase, 60Hz, liquid-immersed, secondary network transformers with a three position grounding switch, subway and vault types, rated 2500 KVA and smaller; primary 34 400 volts and below; secondary 216Y/125 volts and 480Y/277 volts.

A subway-type network transformer is one that is suitable for frequent or continuous submerged operation.

A vault-type network transformer is one that is suitable for occasional submerged operation.

2 Referenced and related American National Standards

This standard is intended to be used in conjunction with the following American National Standards.

2.1 Referenced American National Standards

When an American National Standard referred to in this document is superseded by a revision approved by the American National Standards Institute, Inc., the revision shall not apply. The referenced standard and the specific referenced edition shall be the applicable referenced standard until the new version of the referenced document is incorporated by formal action or appropriate revision of the citing standard. All characteristics, definitions, tests, and voltage designations, except as specifically covered in this standard, shall be in accordance with the American National Standards listed below.

ANSI/ASME B1.1-1989, *Unified Inch Screw Threads (UN and UNR Thread Form)*

ANSI/IEEE C17.12.00-1993, *General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers*

ANSI/IEEE C57.12.80-1978 (R 1992), *Terminology for Power and Distribution Transformers*

ANSI/IEEE C57.12.90-1999, *Liquid-Immersed Distribution, Power and Regulating Transformers, and Distribution and Power Transformer Shop-Circuit Test Guide*

ANSI/IEEE C57.91-1995, *Guide for Loading Mineral Oil-Immersed Power Transformers Up to and Including 100 MVA with 55°C or 65°C Winding Rise*

IEEE Standard 386, *IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V.*

ANSI C57.12.32-1994, *Submersible Equipment – Enclosure Integrity*

2.2 Related American National Standards

These standards are listed here for information only and are not essential for the completion of the requirements of this standard.

ANSI C57.12.70-1978 (R1993), *Terminal Markings and Connections for Distribution and Power Transformers*

ANSI/ASME B1.20.1-1983 (R1992), *Pipe Threads-General Purpose (Inch)*

ANSI/IEEE 100-1996, *Dictionary of Electrical and Electronics Terms*

3 Transformer performance requirements

3.1 Kilovolt-ampere ratings

Kilovolt-ampere ratings shall be as specified in Table 1.

Table 1 – Kilovolt-ampere ratings

55°C	65°C
300	336
500	560
750	840
1000	1120
1500	1680
2000	2240
2500	2800

The base rating as listed in Table 1 shall not exceed a 55°C average winding temperature rise above standard ambient. The 65°C rating is based on not exceeding a 65°C average winding temperature rise or an 80°C hot-spot temperature rise, as specified in ANSI/IEEE C57.12.00. The temperature rise of the insulating liquid shall not exceed 65°C measured near the top of the tank.

The dual-rated transformers, as shown in Table 1, are based on utilizing an insulation system that allow continuous operation at a 65°C rise and 112% of the 55°C base rating. Dual-rated transformers shall also be capable of delivering the 55°C base kilovolt-ampere rating when operated in a 40°C average ambient temperature with a maximum temperature not to exceed 50°C and without exceeding an 80°C hotspot temperature rise.

When required, a kVA base rating with a 65 °C average winding temperature rise can be specified.

3.2 Voltage rating and tap ratings

Preferred voltage ratings and taps shall be in accordance with Table 2. All taps shall be at rated kilovolt-amperes.

Table 2 – Preferred ratings for subway and vault-type secondary network transformers

Preferred nominal system voltage	BIL kV	Note 2 Rating	Transformer primary taps		kVA ratings for secondary ratings of:	
			Above	Below	Note 1 216Y/125	Note 1 480Y/277
2400/4160Y	60	4160	None	None	300–1000	500–1000
		4160Y/2400	None	None	300–1000	500–1000
12 000	95	12 000	None	11 700/11 400/11 100/10 800	300-1000	500–2500
			12 600/ 12 300	11 700/11 400	- - -	500–2500
13 200 or	95	13 200	None	12 870/12 540/12 210/11 880	300–1000	- - -
7620/13 200Y			13 860/13 530	12 870/12 540	- - -	500–2500
	95	13 200Y/7620	None	12 870/12 540/12 210/11 880	300–1000	- - -
			13 860/13 530	12 870/12 540	- - -	500–2500
14 400	95	14 400	None	14 040/13 680/13 320/12 960	300–1000	- - -
			15 120/14 760	14 040/13 680	- - -	500–2500
23 000	150	22 900	24 100/23 500	22 300/21 700	500–1000	500–2500
34 500	200	27 060	29 090/28 414 27 737	26 383	500-1000	500-2500
34 500	200	34 400	36 200/35 300	33 500/32 600	500–1000	500–2500

NOTES
1. Kilovolt-ampere ratings separated by a dash (-) include all ratings within that range.
2. All windings are delta-connected unless otherwise indicated.

3.3 Angular displacement

The angular displacement between primary and secondary terminal voltages of three-phase transformers with wye-wye connections shall be 0 degrees. The angular displacement between primary and secondary terminal voltages of three-phase transformers with delta-wye connections shall be 30 degrees with the primary leading the low voltage.

3.4 Basic lightning impulse insulation levels

Basic lightning impulse insulation levels shall be as specified in Table 2, and the dielectric test levels shall be in accordance with distribution transformer levels in ANSI/IEEE C57.12.00.

NOTE—Cable terminations supplied by the user should provide suitable coordination with the transformer insulation level.

3.5 Percent impedance

The percent impedance on the rated voltage connection shall be as specified in Table 3.

Table 3 – Impedance

kVA rating	Percent impedance
300–1000	5.0
1500–2500	7.0

3.5.1 Impedance Tolerance

The tolerance shall be as specified in ANSI/IEEE C57.12.00.

3.5.2 Tolerance on impedance on a tap

The percent departure of the actual impedance on any tap from the actual impedance at the rated voltage shall not be greater than the total tap voltage range expressed as a percentage of the rated voltage.

3.6 Audible sound levels

Transformers shall be designed so that the average sound level does not exceed the values given in Table 4 measured according to ANSI/IEEE C57.12.90.

Table 4 – Audible sound levels

Kilovolt-ampere rating 200 kV BIL and below	Average sound level (decibels) dB(A)
300	55
500	56
750	57
1000	58
1500	60
2000	61
2500	62

4 Tests

All tests shall be performed in accordance with ANSI/IEEE C57.12.00 and ANSI/IEEE C57.12.90.

5 Primary disconnect and grounding switch

5.1 General

The primary disconnect and grounding switch shall be a three-pole, three-position switch for disconnecting the primary feeder from the transformer and for connecting the incoming feeder to the ground position. The switch shall be housed in an enclosure welded to the end of the transformer tank. The switch enclosure shall consist of a switch chamber and a primary termination chamber, refer to Figure 2.

5.2 Primary switch electrical performance requirements

5.2.1 Continuous rating

The 60-Hz rating of the switch shall be 200 amperes.

5.2.2 Short-circuit rating

In the ground position, the switch shall be capable of withstanding a short-circuit current of 15,000 amperes rms symmetrical for 5 seconds without impairing the continuous rating or operation of the switch. In the closed position, it shall carry the full short-circuit duty of the transformer winding.

5.2.3 Interrupting rating

The disconnect and grounding switch shall have one of the two following interrupting ratings.

5.2.3.1 No interrupting rating (dead break)

This requires that the transformer be totally de-energized before the switch mechanism can be operated.

5.2.3.2 Magnetizing current interrupting rating (mag-break)

The switch shall be designed to open the primary when only magnetizing current is present. The switch will not operate while a load is present on the secondary. The switch shall have operational protection as specified in paragraph 5.2.6.1 or 5.6.2.2. The magnetizing current interrupting mechanism shall be designed such that, regardless of the speed at which the switch handle is moved from closed to the open position, no damage will occur to the main contacts of the switch.

5.2.4 Dielectric requirements in closed position

The switch shall, as a minimum, be designed to meet the same dielectric values of the transformer to which it is connected. The switch shall be connected to the transformer while dielectric tests are being performed on the transformer.

5.2.5 Dielectric requirements in open position

The dielectric strength of the switch in the open position shall be such as to permit dc 5-minute cable tests in the field as in Table 5:

Table 5 – Cable test requirements

15 kV switches	45 kV
25 kV switches	65 kV
34.5kV switches	85 kV

5.2.6 Electrical interlock

5.2.6.1 Interlock protection when no interrupting rating is required

An electrical interlock shall prevent movement of the switch from any position when the transformer is energized.

5.2.6.2 Interlock protection when magnetizing current interruption is required

An electrical interlock shall be provided to prevent movement of the switch operating mechanism while the network protector is in the closed position. This interlock will permit the switch to operate from the closed to the open position with the primary feeder energized and the network protector in the open position. This interlock shall lock when de-energized.

A second electrical interlock shall be provided to prevent switch movement into the ground position while the transformer is energized.

5.2.6.3 Interlock testing

The electrical interlock coil shall be tested with, and shall withstand, the same 60-Hz, 1-minute dielectric test as the secondary winding.

5.2.6.4 Operating values

The interlock shall pick up and drop-out at the voltages shown in Table 6.

Table 6 – Interlock coil requirements

Coil voltage	Maximum pick-up voltage	Minimum drop-out voltage	Maximum excitation voltage
125	90	15	140
277	200	33	310

5.2.6.5 Interlock assembly

The interlock assembly shall be such that, with the locking lug or latch mechanism blocked and the coil energized at the voltage indicated, the functional performance of the coil will not be impaired.

5.3 Primary switch mechanical features

5.3.1 Primary switch and cable terminal chamber covers

A bolted and gasketed cover shall be provided for both switch and terminal chambers. The covers shall be equipped with handles and guide pins. Where cemented gaskets are used, means for breaking the seal shall be provided. Liquid or compound for the terminal chamber is not supplied.

5.3.1.1 Vent and level plug

A 0.25-inch NPT opening with a pipe plug shall be provided in the terminal chamber cover at the 25°C liquid or compound level.

5.3.2 Primary switch operating positions and sequence

The three operating positions, as well as the sequence of operation, shall be open, closed, and ground. The switch shall be designed so that when it is moved from open to ground, or from ground to open, a pause is enforced in the closed position to allow time for the electrical interlock to engage if the transformer is energized.

These positions shall be indicated by suitable markings located near the external operating handle and visible from the primary end of the transformer.

5.3.3 Operating handle

The switch-operating handle shall be provided with a latch to prevent accidental movement of the switch. Means shall be provided for padlocking the switch in each position.

5.4 Primary switch accessory equipment

The accessory equipment for the primary switch shall be provided and located approximately as shown in Figure 2.

5.4.1 Filling provisions

Both the switch chamber and the terminal chamber shall be provided with 1-inch NPT female openings provided with pipe plugs.

5.4.2 Air test provision

The air test provision shall be provided for the switch chamber and shall consist of 0.5-inch NPT opening equipped with a 0.5-inch NPT pipe plug and shall be located above the 85°C liquid level.

5.4.3 Liquid-level Indicator

A submersible type, welded-on non-gasketed type magnetic liquid-level indicator with a dial (inside bezel) face diameter of approximately 75 mm (3 inches) shall be provided on the switch chamber. The gauge shall have a dark dial face with light markings and a light indicating hand. The dial markings shall show the 25°C level and the minimum and maximum levels. The words “Liquid Level” shall be on the dial or on a suitable nameplate mounted adjacent to the indicator.

5.4.4 Drain provisions

5.4.4.1 Primary switch chamber

A globe type drain valve with 1-inch NPT threads shall be provided. The drain valve shall have a pipe plug in the outer end of the valve. A non-conducting thread sealer is required.

5.4.4.2 Terminal chamber

A 1-inch NPT female openings with pipe plugs shall be provided.

5.5 Primary cable entrance

The primary cable entrance shall be by means of one of the following methods.

5.5.1 Wiping sleeves

Entrance shall be by means of either three single-conductor or one three-conductor straight, tinned, tapered wiping sleeve or sleeves of brass, bronze, or copper that are brazed, welded, or bolted to the terminal chamber. Three single conductor sleeves or one three-conductor sleeve shall be provided as specified. Further details are found in Figure 1.

5.5.2 Entrance fittings

Entrance shall be by means of either three single-conductor or one three-conductor bolted-on entrance fittings. Three single-conductor or one three-conductor fitting shall be provided as specified. Further details are found in Figure 1.

5.5.3 Bushings and bushing wells

Entrance shall be by means of bushings or bushing wells for connection to the distribution system through adapters, separable insulated connectors, or both.

6 Construction

6.1 General

The transformer enclosure shall consist of a tank, radiators, a primary switch, a secondary network protector throat, bushing termination, and acessories as specified in this document. The primary switch is welded to one end of the transformer tank. The network protector throat is welded to the other end.

6.2 Corrosion resistance

6.2.1 Transformer enclosure

The transformer enclosure shall be constructed of materials that provide corrosion resistance equivalent to not less than the thickness of copper-bearing steel shown in Table 7 (minimum copper content: 0.20%).

Table 7 – Minimum material thickness

Transformer enclosure	Subway type mm-(inches)	Vault type mm – (inches)
Tank wall	8 –(0.31)	8 – (0.31)
Switch housing	8 – (0.31)	8 – (0.31)
Auxiliary coolers	8 – (0.31)	2.5 – (0.09)
Cover	13 – (0.5)	13 – (0.5)
Tank bottom	13 – (0.5)	13 – (0.5)

6.2.2 Hardware

All external hardware, nuts, bolts, washers, etc., shall be austenitic stainless steel, silicon bronze, or the functional equivalent.

6.2.3 Other materials

All valves, fittings, pipe plugs or caps, bushings, and cable entrances shall also have corrosion resistance properties, as stated in 6.2.2. Any thread sealant used shall be non-conducting.

6.2.4 Finish

The finish shall be a dark color and conform to ANSI C57.12.32, *Submersible Equipment—Enclosure Integrity.*

6.3 Tank

6.3.1 General

The transformer tank shall be of sealed construction, consisting of a welded main cover equipped with a handhole cover and a subbase. The completely assembled tank shall be of sufficient strength to withstand a pressure of 50 kPa (7 psig) without permanent deformation and 105 kPa (15 psig) without rupture. The completely assembled transformer shall be tested for leaks using a minimum pressure of 50 kPa (7 psig) above the static head of liquid for not less than 6 hours. Alternative methods for leak detection, such as the helium leak detector method, may also be used.

6.3.2 Transformer with subbase

The transformer subbase shall consist of bars parallel to the long axis of the transformer. The subbase shall provide a 38 mm (1.5-inch) minimum clearance from the floor to the tank bottom, with corners left clear for jacking.

6.3.3 Secondary throat

Secondary throat (Item 10, Figure 2) shall be suitable for connecting to a network protector. A gasket shall be provided for use between the throat and the protector. Bushing spacing, throat dimensions, terminal details, and application shall be as specified in Table 8.

Table 8 – Secondary throat details

Secondary voltage and kVA ratings		
216Y/125	**480Y/277**	**Figure number**
300, 500	500, 750, 1000	3
750, 1000	1500, 2000, 2500	4

6.3.4 Handhole cover

A handhole with a welded cover shall be provided for disconnecting the neutral or neutrals for test and for mounting a pressure-relief device when present. A welded cover shall be furnished.

6.3.5 Lifting lugs

Four lifting lugs shall be arranged to facilitate lifting the transformer with or without the network protector attached. The lugs shall be provided with a suitable hole for attaching a 400 mm (1.5 inch) clevis.

6.3.6 Lifting and jacking provisions

Lifting and jacking provisions shall be designed to provide a safety factor of 5. This safety factor is the ratio of the ultimate stress of the material used to the working stress. The working stress is the maximum combined stress developed in the lifting provisions by the static load of the completely assembled transformer.

6.3.7 Secondary throat shipping guard

A sealed sheet steel cover pan, fully flat gasketed, shall be installed over the secondary throat to prevent mechanical and corrosive damage to the secondary bushings, external connectors, and throat flange during shipment and storage outdoors. The throat cover shall be bolted securely to the flange of the secondary throat. The cover shall be completely enclosed to prevent entrance of air-borne chemicals or moisture that may corrode these external parts. The cover shall be painted.

6.4 Accessory equipment for transformer tanks

Accessory equipment is that equipment which shall be provided as part of the transformer. The approximate location of such equipment is shown in Figure 2.

6.4.1 Tap changer

A tap changer for de-energized operation shall be provided. Each tap changer position and the associated tap voltage shall be clearly identifiable by reference to nameplate information. All positions of the tap changer shall be operative positions. The tap changer shall be of sealed construction such that the integrity of the main tank seal is not compromised at any time. The tap changer shall be designed with an external operating means available under a protective cap on top of the main tank. An indicator shall clearly show the tap position when the cap is removed.

6.4.2 Air test provision

The air test provisions shall consist of a 0.5-inch NPT opening equipped with a 0.5-inch NPT pipe plug and shall be located above the 85°C liquid level.

6.4.3 Welded-on, non-gasketed-type, magnetic liquid-level indicator

Refer to paragraph 5.4.3 for the requirements for the liquid level indicator.

6.4.4 Dial-type thermometer without alarm contacts

The diameter of the dial (inside bezel) shall be approximately 115 mm (4.5 inches). The thermometer shall be the direct-stem type, mounted in a closed well at a suitable level to indicate the top liquid temperature. The thermometer shall have a dark dial face with light markings, a light-colored indicating hand, and an orange-red maximum indicating hand, with provision for resetting. The dial markings shall cover the range from 0^{o}C to 120^{o}C. The words “Liquid Temperature” shall be on the dial or on a suitable nameplate mounted adjacent to the indicator.

6.4.5 Combination drain and bottom filter valve

Refer to paragraph 5.4.4.1 for the drain valve requirements.

6.4.6 Filling plug and upper filter press connection

The filling plug and upper filter press connection shall be located in the cover and shall consist of a 1 inch NPT female opening with plug.

6.4.7 Ground pads

Tank-grounding provisions shall consist of a copper-faced steel or stainless steel pad with two holes horizontally spaced on 44.5 mm (1.75 inch) centers and drilled and tapped for 0.5-inch 13-UNC thread. The ground pad shall be welded to the tank. The minimum thickness of the copper facing shall be 0.4 mm (0.015 inch). The minimum threaded depth of the holes shall be 13 mm (0.5 inch). Thread protection for the ground pad shall be provided.

6.5 Dimensions

Dimensions, including the secondary flexible connectors (without the network protector attached), shall not exceed those shown in Table 9. These dimensions are intended to guide the user in planning vaults capable of accommodating all current designs of the network transformers covered by this standard.

7 Bushings

7.1 Primary bushings

7.1.1 Primary bushings between the main tank and the switch chamber

These bushings shall be sealed to prevent the interchange of liquids between compartments. The insulators of the bushings shall be replaceable from the switch chamber.

7.1.2 Primary bushings between the switch chamber and the terminal chamber

These bushings shall be sealed to prevent interchange of liquids or compounds between compartments. They shall be the stud type, and the interior distance from the top of the stud to the top of the terminal chamber shall be as specified in Figure 1.

7.1.3 Primary entrance

The primary entrance to the terminal chamber when bushings or bushing wells are required for connection to the distribution system shall be by means of adapters or separable insulated connectors, or both. Reference IEEE Standard 386, *IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V*.

7.2 Secondary bushings

The secondary bushings shall be located inside the secondary throat and shall be brazed or welded to the tank. Bushings shall be located as indicated in Figure 2. The bushings shall be externally replaceable.

7.3 Terminal markings

External primary and secondary terminal markings shall be in accordance with Figure 2.

Table 9

Maximum tank dimensions in millimeters (4)

For mineral oil-filled units												
15 kV class and below					25 kV class				35 kV class			
kVA Rating	W	L (1)	H_c (2)	Throat H (3)	W	L (1)	H_c (2)	Throat H(3))	W	L (1)	H_c (2)	Throat H (3)
300	990	1980	1700	1070	—	—	—	—	—	—	—	—
500	1120	1980	1780	1220	1170	2210	1180	1400	1250	2390	1960	1470
750	1190	2130	1880	1400	1220	2360	1880	1550	1300	2540	2030	1730
1000	1320	2190	2140	1450	1400	2470	1990	1530	1470	2670	2290	1860
1500	1430	2440	2190	1575	1530	2540	2190	1650	1600	2770	2370	1960
2000	1630	2670	2470	1780	1780	2950	2260	1780	1960	2980	2670	2140
2500	1780	2670	2570	1910	1910	3280	2410	1910	2140	3330	2960	2290
For silicone-filled units												
300	1070	1780	1780	1070	—	—	—	—	—	—	—	—
500	1220	2090	1830	1220	1250	2210	1180	1400	1320	2390	1910	1470
750	1270	2190	2030	1400	1300	2360	1910	1550	1370	2540	2160	1730
1000	1370	2240	2140	1450	1400	2460	2150	1520	1470	2670	2290	1850
1500	1420	2440	2160	1580	1580	2570	2160	1650	1650	2770	2360	1960
2000	1630	2670	2460	1780	1780	2950	2490	1780	1960	3050	2620	2130
2500	1780	3050	2570	1910	1960	2280	2670	1910	2130	3330	2870	2290

Notes

(1) "L" includes the flexible secondary bushing adapter (excludes the network protector).

(2) "H_c" is the height from floor to cover.

(3) Maximum height from floor to centerline of throat.

(4) Transformers with other insulating liquids may require different dimensions.

Maximum tank dimensions in Inches (4)

For mineral oil-filled units												
15 kV class and below					25 kV class				35 kV class			
kVA Rating	W	L (1)	H_c (2)	Throat H (3)	W	L	H_c (2)	Throat H (3)	W	L	H_c (2)	Throat H (3)
300	39	78	67	42	—	—	—	—	—	—	—	—
500	44	78	70	48	46	87	70	55	49	94	77	58
750	47	84	74	55	48	93	74	61	51	100	80	68
1000	52	86	84	57	55	97	78	60	58	105	90	73
1500	56	96	86	62	60	100	86	65	63	109	93	77
2000	64	105	97	70	70	115	89	70	77	117	105	84
2500	70	105	101	75	75	129	95	75	84	131	115	90
For silicone-filled units												
300	42	80	70	42	—	—	—	—	—	—	—	—
500	48	82	72	48	49	87	70	55	52	94	75	58
750	50	86	80	55	51	93	75	61	54	100	85	68
1000	54	88	84	57	55	97	85	60	58	105	90	73
1500	56	96	85	62	62	101	85	65	65	109	93	77
2000	64	105	97	70	70	115	98	70	77	120	103	84
2500	70	120	101	75	77	129	105	75	84	131	113	90

8 Neutral termination

8.1 Primary neutral

Transformers having wye-connected primary windings shall have the primary neutral internally connected to the secondary neutral by means of a removable link.

8.2 Secondary neutral

A fully rated secondary neutral shall be a blade welded to the tank opposite the internal boss or, when specified by the user, a fully insulated bushing. The neutral termination shall comply with the requirements in Table 10.

If a bushing is used, removable ground straps, sized for the short circuit rating of the transformer, shall be provided and connected between the neutral bushing and a ground pad. The ground pad shall have two 0.5 -13 UNC tapped holes welded to the tank wall and located a minimum of 300 mm (12 inches) from the bushing center.

Table 10 – Secondary neutral

Secondary rating (kVA)		
216Y/125	**480Y/277**	**Number of holes**
300, 500, 750, 1000	500, 750, 1000, 1500, 2000, 2500	4 6

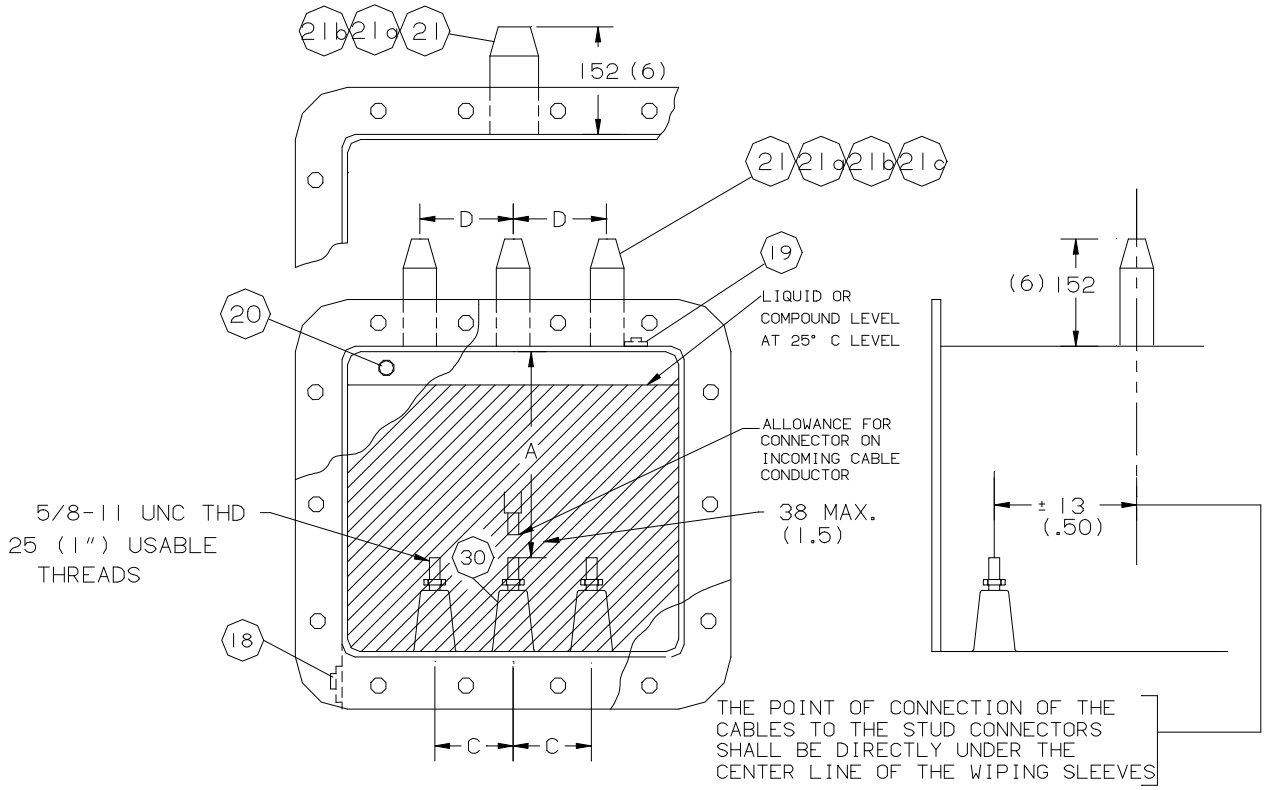
9 Nameplate

The namplate shall be mounted on the primary terminal chamber cover, as shown in Figure 2. The nameplate shall conform to the requirements of the nameplate “C” as described in ANSI/IEEE C57.12.00 and shall be modified to include the following:

a) type (subway or vault)
b) the words “Network Transformer”
c) approximate volume of liquid in switch
d) approximate volume of liquid in transformer
e) interlock coils and connections
f) type of primary switch

10 Connections of transformer for shipment by the manufacturer

The transformer shall be shipped connected for the rated high voltage.



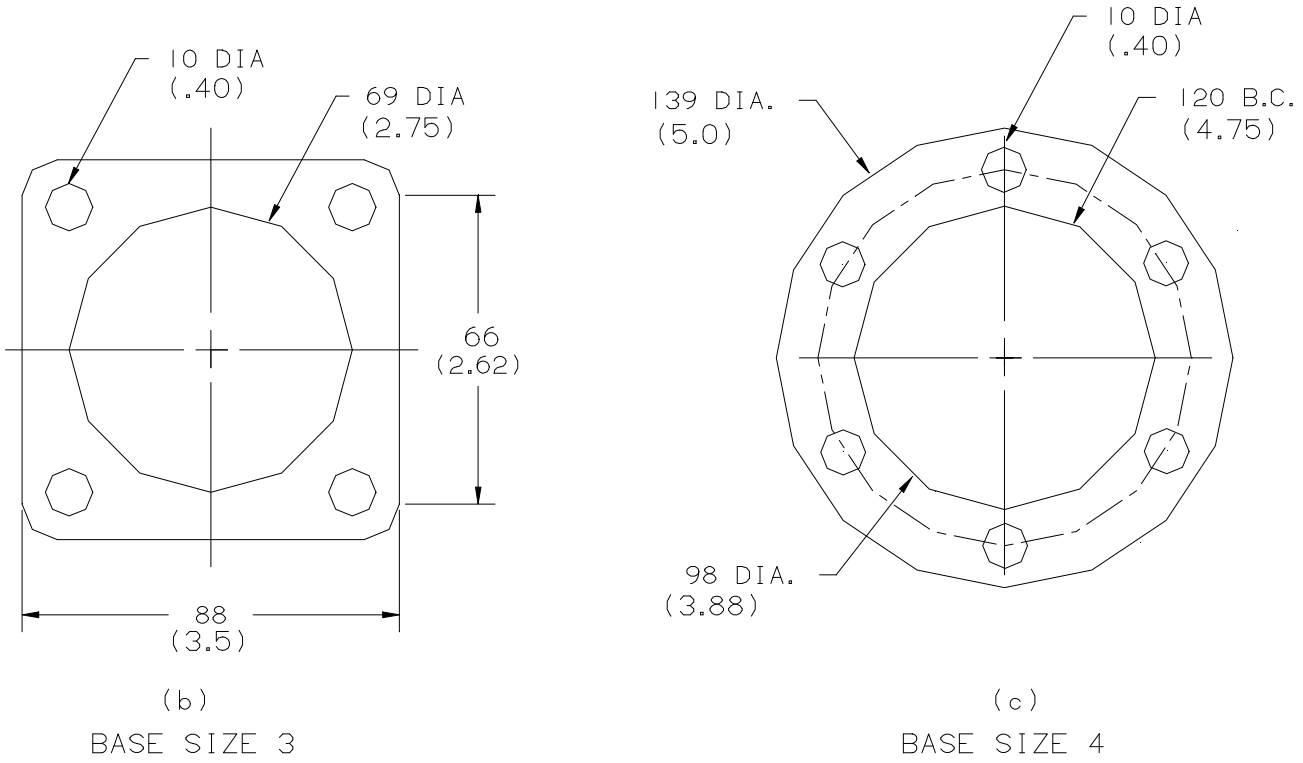
High voltage	Dimensions				
BIL (kV)	**A (min.)**	**B (max.)**	**C (min.)**	**E (min.)**	**F**
95 and below	270 mm (10.5 in)	13 mm (0.5 in)	115 mm (4.5 in)	152 mm (4.5 in)	± 13 mm (0.50 in)
150	370 mm (14.5 in)	25 mm (1.0 in)	155 mm (6.0 in)	152 mm (4.5 in)	± 13 mm (0.50 in.)
200	470 mm (18.5 in)	25 mm (1.0 in)	165 mm (6.5 in)	152 mm (4.5 in)	± 13 mm (0.50 in.)

Item number	Section reference	Description
18	5.4.4.2	Drain plug
19	5.4.1	Filling plug
20	5.3.1.1	Vent and level plug
21	5.5	Primary cable entrance
21a	5.5.1	Three single-conductor wiping sleeves (brazed or welded on)
21b	5.5.2	Three single-conductor entrance fittings (bolted on)
21c	5.5.3	Separable insulated connectors (plug-in bushings or wells)
22a	5.5.1	One three-conductor wiping sleeve (brazed or welded on)
22b	5.5.2	One three-conductor entrance fitting (bolted on)
30	7.1	Primary bushings

NOTES
1 Dimension “C” = “D” when wiping sleeves are used and may vary by ±13 mm (0.50 inches) when wiping sleeves are not used.
2 Allowance for connectors on incoming cable = 38 mm (1.50).

(a)
Chamber

Figure 1 – Primary terminal chamber details



TYPICAL DIMENSIONS

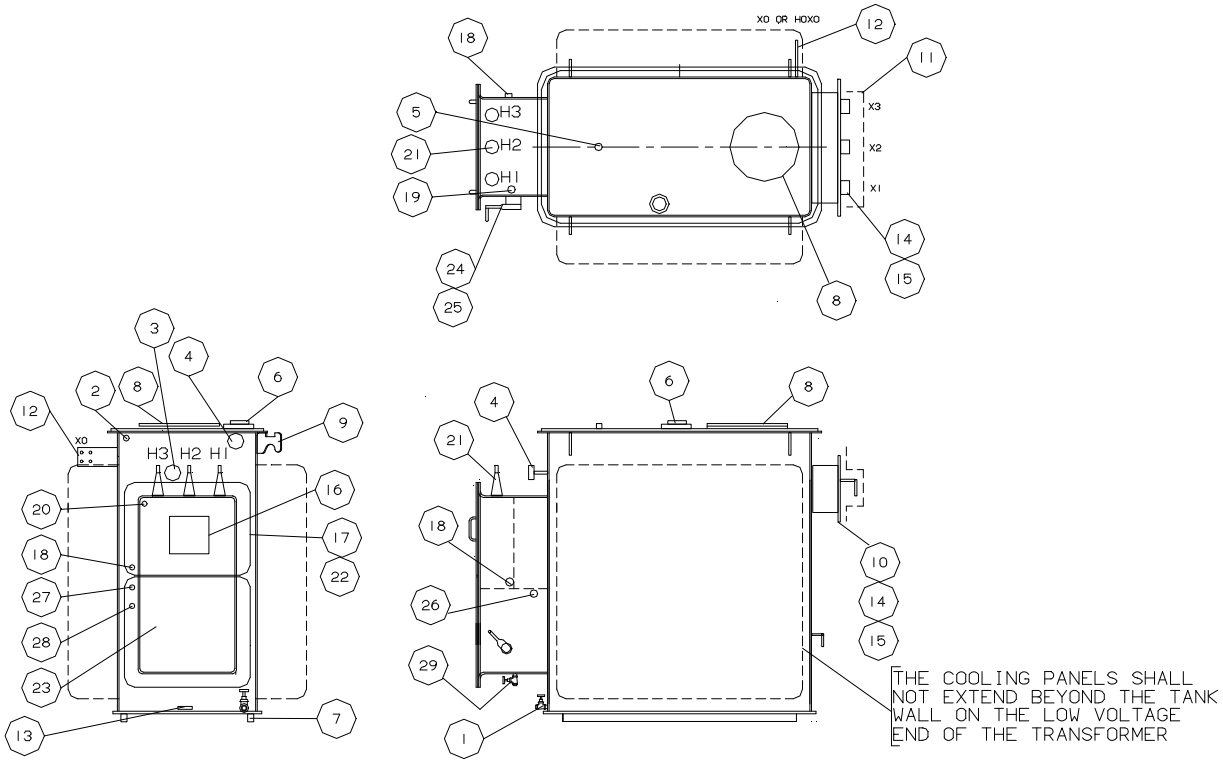
Wiping sleeve dimensions (brazed or welded on)

	Inside diameter (Min.)	Taper to (Max.)	Length of taper (Min.)
Three single-conductor wiping sleeves (item 21a)	45 mm (1.75 in)	29 mm (1.13 in)	38 mm (1.5 in)
One three-conductor wiping sleeve (item 22a)	89 mm (3.5 in)	38 mm (1.5 in)	57 mm (2.25 in)

Entrance fitting (bolted on)

Three single-conductor entrance fittings (item 21b)	maximum base size 3 (fig. 1b)
One three-conductor entrance fitting (item 22b)	maximum base size 4 (fig. 1c)

Figure 1 – continued



Compartment	Item number	Section reference	Description
Transformer tank	1	6.4.5	Combination drain and bottom filler valve
	2	6.4.2	Provision for air test
	3	6.4.3	Welded-on non-gasketed type magnetic liquid-level indicator
	4	6.4.4	Dial-type thermometer without alarm contacts
	5	6.4.6	Filling plug and upper filter press connection
	6	6.4.1	Tap changer
	7	6.3.2	Transformer subbase
	8	6.3.4	Handhole
	9	6.3.5	Lifting lugs
	10	6.3.3	Throat
	11	6.3.7	Shipping guard
	12	8.2	Secondary neutral grounded to tank
	13	6.4.7	External grounding provision
	14	Figure 3	Secondary throat for mounting network protector
	15	Figure 4	Secondary throat for mounting network protector
	16	9	Nameplate location
	17	5.4.4.2	Primary terminal chamber
Primary	18	5.4.4.2	Drain plug
Terminal chamber	19	5.4.1	Filling plug
	20	5.3.1.1	Vent and level plug
	21	5.5	Primary cable entrance
	22	Figure 1	Primary terminal chamber details
	23	5.4.4.1	Primary switch chamber
	24	5.2	Electrical performance requirements
Primary	25	5.3.3	Operating handle
Switch chamber	26	5.4.1	Filling plug
	27	5.4.2	Provision for air test
	28	5.4.3	Welded-on type magnetic liquid-level indicator
	29	5.4.4.1	Drain valve

Figure 2 – Location of accessories (three-position disconnecting and grounding switch)

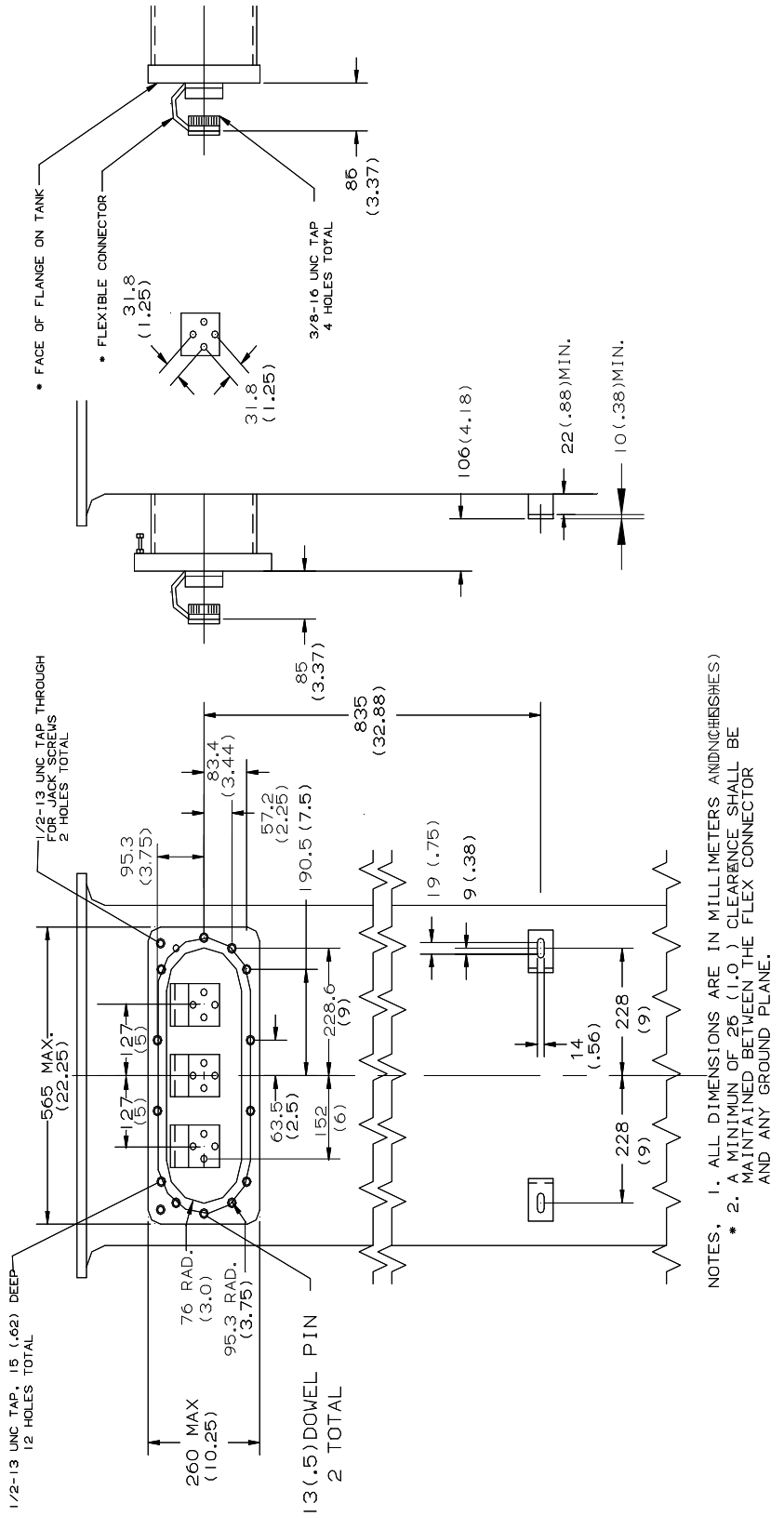


Figure 3 – Transformer throat for mounting network protector
Low voltage 216Y/125 volts, 300 – 500 KVA
Low voltage 480Y/277 volts, 500 – 1000 KVA

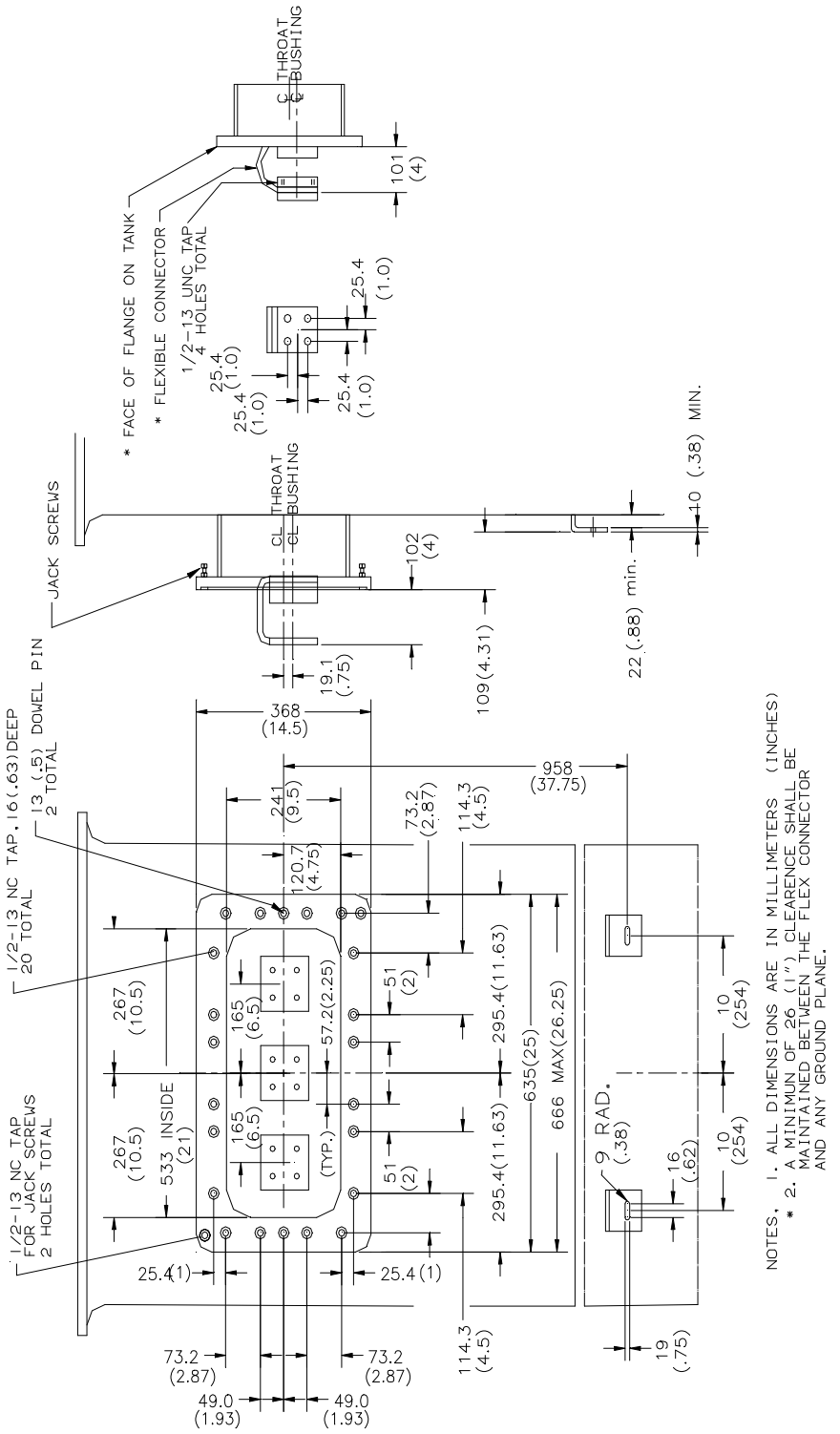


Figure 4 – Transformer throat mounting for net work protector
Low voltage 216Y/125 volts, 750 – 1000 KVA
Low voltage 480Y/277 volts, 1500 – 2500 KVA